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AN EVALUATION OF FOMES ANNOSUS IN BIG BEAR LAKE NORTH SHORE RECREATION AREA SAN BERNARDINO NATIONAL FOREST

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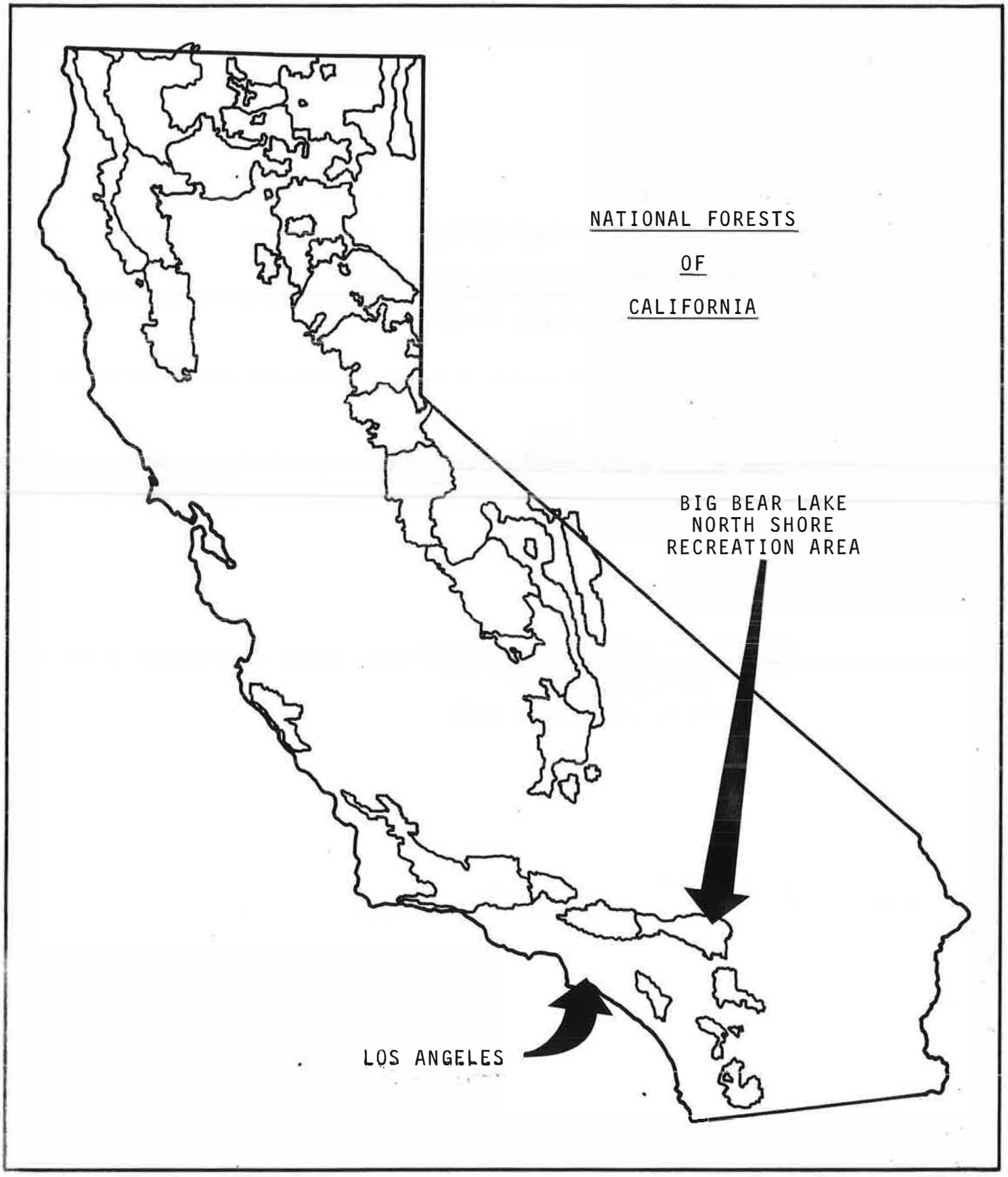
NATIONAL FORESTS
OF
CALIFORNIA
BIG BEAR LAKE
NORTH SHORE
RECREATION AREA
LOS ANGELES

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INTRODUCTION

The Big Bear Lake North Shore Recreation Area is located on the Big Bear Ranger District, San Bernardino National Forest, about 120 km (75 mi) northeast of Los Angeles (Map 1). Big Bear Lake is a 3000 acre reservoir created in 1884 to supply water to citrus groves around Redlands. It lies in a trough-like basin approximately 19 x 8 km (12 x 5 mi), oriented east and west, at an elevation of 2052 m (6738 ft). The lake and surrounding basin are heavily used for recreation by people coming from the Los Angeles area. Water-oriented sports are popular in summer; skiing and other snow-related activities draw large crowds in the winter. Public access to the lake is limited; accordingly, the Forest Service bought 170 ha (420 a) along the north shore of the lake in order to provide recreation opportunities. The proposed development stretches along the shore in a narrow band approximately 4 km (2.5 mi) by 0.4 km (0.25 mi) and occupies a flat area between the lake and the steep lower slopes of Bertha Ridge to the north (Map 2). Two private resorts and a solar observatory operated by California Institute of Technology lie within the project boundary.

The alternative selected in an Environmental Analysis Report (1) is to develop the area for use by about 2000 people per day. Developments include a campground, amphitheatre, day use area, arrival stations, parking lots, and a peripheral bicycle and walking trail. Observations made by the Forest Silviculturist, supported by the results of a compartment inventory conducted in 1977, suggested that annosus root rot might be causing enough damage to warrant special consideration. An inspection made by Bruce Roettgering, Entomologist, and Ed Wood, Plant Pathologist, from the Forest Insect and Disease Management (FIDM) Staff indicated the validity of previous observations and prompted a joint decision by the San Bernardino N.F. and FIDM to conduct a biological evaluation of annosus root rot in sites proposed for development. This biological evaluation included a formal survey which located and marked all identifiable root disease centers, and collected data which could be used in developing a management plan designed to alleviate the effects of root diseases.

VEGETATION

The area proposed for development is covered by the yellow pine type, characterized by Jeffrey pine (Pinus jeffreyi), which dominates the overstory; Jeffrey pine, western juniper (Juniperus occidentalis), and single leaf pinyon pine (Pinus monophylla) are found in the understory. The only hardwood species found in this

type is mountain mahogany (Cercocarpus ledifolius), although black oak, (Quercus kellogii) is found on the slopes to the North. Trees within the area have been cut for cabin construction, firewood, and other similar uses for approximately 100 years, but no commercial logging has taken place. A more complete description of the vegetation and history is contained in the EAR and the Compartment Analysis and Silvicultural Prescription for North Shore Recreation Area Compartment #33 (3).

DISEASES AND INSECTS

Jeffrey pine needleminer (Coleotechnites sp. near milleri), western dwarf mistletoe (Arceuthobium campylopodum), juniper mistletoe (Phoradendron juniperinum), annosus root rot (Fomes annosus), black-staining root disease (Verticicladiella wagenerii), shoestring root rot (Armillaria mellea), red-brown cubical root rot (Polyporus schweinitzii), and juniper butt rot (Fomes juniperinus), are known to be endemic in the area. Trees weakened by these and other causes are attacked and killed by Jeffrey pine beetle (Dendroctonus jeffreyi), California flatheaded borer (Melanophila californica), pine engraver beetles (Ips sp.) and incense-cedar bark beetles (Phloeosinus sp.). With the exception of the root diseases, these pests are of minor importance or can be recognized by District and Forest personnel, and normally can be controlled using silvicultural techniques. An evaluation of V. wagenerii on the Big Bear Ranger District was completed in November, 1977. Armillaria mellea is considered to be of minor importance compared to F. annosus.

THE CAUSAL AGENT

Fomes annosus, the cause of annosus root rot, is a Basidiomycetous fungus, closely related to the common wood decay fungi. It attacks a wide range of woody plants, causing both a decay of wood and a killing of sapwood and cambium.

The fungus spreads overland by spores from conks that are usually produced in decayed stumps, under the bark of dead trees, or under the duff at the root collar. These spores drift through the air and, upon landing on freshly cut pine stump surfaces or wounds in a live tree, germinate and colonize this new habitat. Once established in a stump or tree, the fungus grows through roots until it contacts the roots of adjacent trees (Photos 1 and 2). It then invades these new roots and grows through the new root system. In this way it passes from stumps or dead trees to the roots of live trees and thence into other live trees in an enlarging

circle or center. These centers usually continue to enlarge until they reach barriers such as openings or groups of nonsusceptible plants.

Fomes annosus may remain alive in old infected roots or stumps for many years. Young conifers established within such centers often die shortly after their roots contact old infected roots in the soil.

Fomes annosus attacks most conifers. Resinous conifers, especially pines, are often killed quickly by cambial girdling before appreciable root decay occurs, but extensive decay can on occasion precede the death of a pine. Coniferous species with non-resinous wood, such as true fir or western juniper, usually decay to a much greater extent before they die (Photos 3, 4 and 5). The infection centers in the North Shore Recreation Area contain resinous (Jeffrey pine) and non-resinous species (western juniper). Hardwoods are rarely damaged or killed by this pathogen in California and remain in or become established in centers in which conifers have been killed.

Because centers enlarge when the fungus spreads from root to root, the disease is most damaging in dense stands of susceptible trees where root contacts are frequent. Sparse stands or stands composed of susceptible and resistant trees are less subject to extensive damage. Stand age and tree size are important since roots of large trees extend for greater distances than roots of small trees and thus provide opportunities for spread between trees located farther apart.

METHODS

The following areas were surveyed using the methods described below:

1) Campground, totaling 28 ha (69 a) located between present State Highway 38 on the south, the proposed right-of-way for Highway 38 on the north and west, and the Day Use Area on the east.

2) Amphitheatre, 5.3 ha (13 a), south of the campground.

3) Parking lot located north of Marrone's Resort, 2.0 ha (5.0 a). Steps 2 and 3 below were omitted.

4) Parking lot at Cobble Creek Trailhead, 2.5 ha (6.2 a). Steps 2 and 3 below were omitted.

5) Eastern Arrival Station, 7.2 ha (17.7 a). Steps 2 and 3 below were omitted.

6) Day Use Area, 19 ha (48 a), bounded by the proposed Highway 38 on the north, the campground and Marrone's resort on the west, the lake on the south, and the meadow south of Fawnskin Ranger Station on the east.

Each area was systematically inspected by marking strips 80-100 m (260-330 ft) wide and oriented North-South with flagged stakes and inspecting every tree and stump within the strips for signs and symptoms of root diseases. The crew consisted of three persons who were arranged so that one person followed a compass bearing along the eastern edge of the strip and placed flagged stakes every 20-40 m (65-130 ft). A second person followed the western boundary of the strip, and retrieved the flagged stakes marking the eastern boundary of the previous strip. The third person roamed between the other two. All crew members scanned the area within the strip for stumps, and dead, off-color, or fading trees. All stumps were inspected and dissected to determine the presence of decay and sporophores. All dead and dying trees were chopped into at or below ground line.

When indicators of root disease fungi were found, the crew converged on the center and:

1) Identified the root disease.

2) Mapped the center on graph paper at a scale of 1:240, showing all stumps, dead and dying trees, and the healthy-appearing trees around the margin.

3) Referenced it to a Control Point (CP) used in surveying the campground, by compass bearing and distance from the CP to the center.

4) Placed a white-painted stake bearing the words "Fomes annosus" and the center number at the geographical center of the infection.

5) Located and marked it on aerial photographs (1:8000 scale) and on large-scale maps (1:1200 scale) (Map 2). Copies of the photos and the maps have been given to the San Bernardino National Forest.

6) Determined the potential for spread of the fungus to trees not now apparently infected.

RESULTS

CAMPGROUND

Forty-six root disease centers were found in and around the campground loops (Map 2, Photos 1-5). About 20% of these were estimated to be multiple infections which spread and coalesced. Forty-two centers were caused by F. annosus, two by A. mellea, one by V. wagenerii. The cause of one center could not be identified. Of the 42 F. annosus centers, 31 were judged to have further spread potential; 11 are not likely to spread. Size of the centers varied from less than 0.05 ha (0.1 a) to 0.14 ha (0.35 a). Some of the centers marked and mapped as separate are so close to each other, with so few green trees between them, that they have in effect coalesced. Two of these combined centers, 8-11 and 34-36, are approximately one acre in size; both of them are in campground loops. The estimated area affected by root diseases in the proposed campground is 2.5 ha (6 a) out of the 28 ha (69 a). Eight percent of the campground area is now infected by root diseases, principally F. annosus.

AMPHITHEATRE

Two F. annosus centers were discovered near the proposed amphitheatre, one of them approximately 35 m (105 ft) from it. The proposed amphitheatre is located immediately adjacent to a dense grove of tall (45-60 m, 135-180 ft) Jeffrey pines with an understory of junipers. At the present time, only junipers have died in these centers, but two declining pines were observed on the edge of center #31.

DAY USE AREA

Six F. annosus centers were found in this area, concentrated along Highway 38. Since none of them are located within the area to be developed, they are not considered to be a problem.

PARKING LOT NORTH OF MARRONE'S RESORT

Two V. wagenerii centers were found to the west of the parking lot. Both of these centers in pinyon pine have potential to spread, but only one of them may slightly effect the development.

PARKING LOT, COBBLE CREEK TRAILHEAD

No root disease centers were found.

EASTERN ARRIVAL STATION

Six F. annosus centers were found, all with spread potential; the fungus is killing small trees in two of the centers, close (40 m, 120 ft) to proposed developments and should not post a serious hazard to the development. Trees in this area are used by eagles as perches. The main effect of the fungus in the four centers located at a distance from proposed developments appears to be the gradual killing of mostly small trees, but including some that are large enough to be used by the birds.

RECOMMENDATIONS

PREVENTION

Borax. Dry, powdered borax is registered for stump treatment to prevent infection by F. annosus. While borax does not control existing infections, it is about 90% effective in preventing new centers, and must be used on all stumps created by cutting trees for construction and maintenance of facilities in this recreation area (FSM R-5 Supplements 2305 and 2331.33).

High stumps. Fomes annosus spores have a limited tolerance to high temperature and low moisture in stumps. Most stumps in recreation areas are cut flush with the ground, creating favorable conditions for infections. If, however, stumps are left 50-60 cm (18-24 in) high when thinning, internal temperatures and moisture levels have been reported to be such that the fungus dies before reaching the roots. The roots then become occupied by secondary fungi which prevent F. annosus from establishing itself. While this method appears to be effective, it has not been fully tested to see how many infections result, nor is it known how long the high stumps must be left before they can be cut flush with the ground. Although this method was discussed during an on site inspection, it cannot be recommended because it has not been adequately tested.

CONTROL

Fomes annosus is seldom controlled in the usual sense of the term. Instead, stand factors are manipulated so that the impact of the fungus is lessened. However, one control measure appears feasible in this recreation area because capital investment is high, and because the conifers contribute greatly to its value for recreation.

Buffer Strips. Several centers were observed that would cease to spread if a strip of conifers beyond the margin of the existing center were cut and the stumps removed. If done over large areas, this treatment would increase the size of clearings, but where openings, roads or other limits to spread exist, and treatment can be applied to only a few small trees, it appears feasible. Center #4, for instance, would not spread further if three or four junipers on the east and south sides were removed. A pathologist familiar with this fungus should decide where to remove trees, and which trees to remove.

Tree removal can be done by attaching a cable to a tree at about mid-bole and pulling on it with a small crawler tractor or similar machine. Minimum site disruption occurs when pulling is done when the ground is dry.

Stump Removal. If stumps from trees killed by the fungus are uprooted and removed, much of the inoculum source is removed, and the center presumably will not remain infectious for as long as time as when they are left. This method is disruptive and expensive when trees and stumps are large, and cannot be recommended.

MEASURES DESIGNED TO MINIMIZE IMPACT

All of the following measures will serve to lessen the effects of tree loss and should be undertaken.

Removal of Infected trees. Trees exhibiting symptoms and those judged by a pathologist as likely to die in the next five years, as well as those that are a public safety hazard, should be marked and removed as soon as possible, or at least before construction starts. Removing them would allow the trees to be felled with less damage to remaining vegetation, and prevent damage to facilities or plantings. If trees are felled before construction they can be removed from the site; if they are felled after construction, they will have to be left on the ground. It is recommended that no dead trees be left standing in or near areas receiving heavy use, including those surveyed for root rots. If declining pines and junipers are removed well before construction begins, the centers can be replanted to nonsusceptible species, allowing the reproduction to become established before the campground is used with less competition from existing trees and with less risk of damage. However, delaying removal until just before construction begins would allow a re-examination to be made to determine if additional trees are declining.

Annual Tree Inspection. An annual inspection should be made by a person trained in hazard tree recognition to detect those trees which are, or will soon become, a hazard. This person could be a pathologist or entomologist from FIDM, Region 5, or a Forest or District

employee trained by FIDM personnel.

Replanting Centers. The Silvicultural Prescription addresses the ways in which stands will be preserved or new ones regenerated, but the F. annosus centers are a special case. Since all conifers are susceptible to annosus root rot while hardwoods are resistant or immune, it seems obvious to recommend the planting of hardwoods around and in infection centers. It is important that planting be done beyond the existing limits of centers because the diameter of these centers can be expected to increase at a rate of approximately 1.5-2.0 m (4-6 ft) per year. A number of hardwood species might be used, including native hardwoods such as mountain mahogany and black oak, or non-native species such as aspen. Mountain mahogany is a shrubby, slow-growing species which will not provide shade for a number of years, but which appears to be well-adapted to the site and which is aesthetically pleasing. Black oak is not found on the actual site, but is present on the ridge to the north and might do well in this area. Seedlings may be obtained from planted acorns, or from wildlings dug up and transplanted. The latter method has the advantage of providing seedlings for planting next spring, and also for providing large seedlings or saplings. It is desirable to plant the centers as soon as possible in order to allow time for the trees to become established before the area receives heavy use. Whatever method is followed, the planted stock must be protected from contact with people, using rocks, stakes, or screening.

Quaking aspen, Populus tremuloides, has been proposed for planting. Aspen is desirable because it grows rapidly, it is colorful, it drops its foliage in the winter when more light is needed in a campground, and it regenerates by means of suckers from roots. However, it is susceptible to injury, is easily infected by canker and decay fungi, and is relatively short-lived. Aspen should be considered as a "cover crop" which will remove itself as other vegetation becomes established, perhaps 30-40 years after planting.

Points to consider if aspen is planted are:

- Trees should be small, 1-3 feet in height, unless a large root ball can be obtained. Small root balls usually result in invasion by pathogens and death of the trees. At best, mortality rate will probably be around 50%.

- Protection should be provided until trees are established. Small trees will grow 2-3 feet per year, but can be easily trampled. It may be necessary to irrigate seedlings.

- Aspen is especially susceptible to camper-caused injury because of its smooth, white, thin bark, which seems to invite

attacks, and which offer poor resistance to those attacks. Canker fungi become established in the wounds and result in the gradual decline of the tree. An attempt should be made to educate the recreation area users to the dangers of tree-scarring. This could be done by means of informational handouts, such as "Trees Need Their Skin, Too!" (2), by signs located near planted aspens, and by informational displays at arrival stations, entry stations, or the visitor information center.

- Under normal conditions, aspen will produce suckers at 8-12 years of age. These suckers can appear up to 15 m (50 ft) from the parent tree, and may serve to assist in revegetating the area planted.

- If wildlings are obtained for planting, the form of parent trees should be examined. Since aspen seedlings are usually clones, parents with scrubby form and low branches can be expected to produce similar-appearing offspring.

- Aspens should never be pruned. Branch stubs are entrance courts for pathogenic fungi.

- Wound paint is not effective in controlling canker and decay fungi.

Several references (4,5,6) from the Rocky Mountains explain in detail the problems associated with quaking aspen in campgrounds and should be examined before planting this species.

Location of Structures. It is possible at this time to locate structures such as restrooms, asphalt pads, or roads, in order to better utilize the area. Where possible, roads and other areas covered with asphalt should be located in infection centers. If this is done, more of the existing trees will be left and less of the infected area will have to be planted. Facilities such as restrooms, entry stations, and the amphitheatre should not be constructed on or near the margins of centers containing large trees, unless those trees are to be removed. Those trees will eventually die, and removal is often complicated and expensive. If other considerations allow it, structures can and should be located in centers where there is little chance that trees will damage them. The site disruption accompanying construction will probably cause additional infections, but locating these structures in existing centers will result in fewer new ones.

Relocating Facilities. It must be recognized that F. annosus has had and will continue to have a major impact on the pines and junipers in the campground area. Many of the clearings are caused

by this fungus, and it will continue to spread. The vegetation will gradually change from a type dominated by Jeffrey pines and western junipers to one consisting of planted trees and those natives which have escaped the fungus. An alternative that should be critically examined is that of moving campground loops, etc, to uninfected areas. For instance, Whisper Wood loop might be moved to the west, to an area which contains centers only along the proposed highway right-of-way, and Summer Wind loop might be relocated in the area now proposed for the amphitheatre, where there are only two centers. Both of these areas are essentially free of root diseases at this time; locating campground loops, etc., in them would greatly simplify vegetation management. Some new root rot centers can be expected as a result of construction; how many is unknown but depends on the amount of disruption of roots, scarring of trees, and number of stumps. Moving the development to a new area might result in moving the problem to a new area if care is not taken to avoid injuring trees during construction.

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Center #14. Dead and dying Jeffrey pines around a Jeffrey pine stump, indicated by the stake, which was infected by F. annosus. Resin-soaked roots and sporophores were found on trees in the center.

Center #16. Dead and declining western junipers around a Jeffrey pine stump, which contained F. annosus decay and sporophores.

Center #1. Western juniper windthrown while alive, showing advanced F. annosus decay in roots, the Jeffrey pine stump which was the source of infection, and the white stake marking the center.

Center #6. Live western juniper pushed over by survey crew, showing advanced F. annosus decay in 80% of the structural roots.

Center #4. Declining western juniper with dead, stained portion of root infected by F. annosus No decay was visible in the root closer than two feet from the root collar.